



# MICHELS PIPE SERVICES

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P.O. Box 128 • 817 West Main St. • Brownsville, WI 53006-0128  
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## DIVISION 2- SITE WORK SECTION 02760 RESTORATION OF UNDERGROUND PIPE/STRUCTURES

### MANHOLE REHABILITATION

#### PART 1- GENERAL

**A.** Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

#### 1.01 SUMMARY

**A.** Furnish labor, materials, equipment, and supervision to provide a system for manhole reconstruction that stops inflow, infiltration, exfiltration, restores the structural integrity, and provides protection against corrosion. Work includes providing pre-mixed, ready-to-use hydraulic cement patching material, cementitious, micro silica and fiber enhanced wet shotcrete material, a 100% solids thixotropic epoxy coating system designed for vertical high build applications, and tape for sealing Joints inside manholes particularly between the metal frame casting and the cone section

#### 1.02 REFERENCES

**A.** This specification shall govern all work, materials, and equipment required for manhole rehabilitation for the purpose of eliminating infiltration, providing corrosion protection, repair of voids, and restoration of the structural integrity of the manhole as a result of applying a monolithic fiber-reinforced structural and structurally enhanced cementitious liner to the wall and bench surfaces of brick, concrete, or any other masonry construction material. Where deemed necessary, for added corrosion protection, the addition of a minimum 30 mil application of a hydrogen sulfide resistant, 100% solid epoxy coating shall be installed.

**B.** Described are procedures for manhole preparation, cleaning, application and testing. The applicator, approved and trained by the manufacturer, shall furnish all labor, equipment and materials for applying a cementitious mix to form a monolithic liner of a minimum 1/2 inch thickness, to a maximum depth of 3 to 4 inches. All aspects of the installation shall be in accordance with the manufacturer's recommendation and with the following specifications which includes...

1. The removal of any loose and unsound material.
2. The cleaning of the area to be rehabilitated with high pressure water.
3. The repair and filling of voids.
4. The repair and sealing of the invert and benches.
5. The elimination of active infiltration prior to making the application.



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6. The spray application of a microsilica enhanced cementitious mix to form a structural and structurally enhanced monolithic liner.
7. The spray application of a hydrogen sulfide resistant, 100% solid epoxy coating.
8. The installation of the resin treated joint sealing tape.

## 1.03 SUBMITTALS

- A. **DOCUMENTATION:** The applicator shall submit for approval product data sheets and MSDS and for each of the products used.

## 1.04 QUALITY ASSURANCE

### A. QUALIFICATION

1. **MANUFACTURER:** Company specializing in manufacturing the products specified in this section shall have a minimum of 10 (ten) years documented experience in cementitious and epoxy repair and protection as well as product manufacturing.
2. **APPLICATOR:** Company specializing in performing the work of this section shall have a minimum of 3 (three) years documented experience, and shall have prior approval of the repair materials manufacturer. Applicators not certified approved by the manufacturer, refer to MOCKUP.

## 1.05 PRE-INSTALLATION CONFERENCE

- A. **MOCKUP:** Applicators not certified by the repair materials manufacturer shall provide a mockup of manhole repairs including surface preparation, plugging, patching, and applying spray and/or hand applied repair and protection materials.
- B. **NOTIFICATION:** A notification of the manufacturer's authorized representative must be given at least 2 weeks before the start of work..

## 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in original factory packaging bearing identification of product, manufacturer, batch number, and expiration data as applicable.
- B. Store the product in a location protected from damage, construction activity, and precipitation in strict accordance with the manufacturer's recommendations.



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## 1.07 ENVIRONMENTAL REQUIREMENTS

- A. Do not use specified product under conditions of precipitation or freezing conditions. Use appropriate measures for protection and supplementary heating/cooling or to ensure proper drying and curing conditions in accordance with the manufacturer's recommendations.
- B. Repair materials manufacturer shall provide Material Safety Data Sheets. The applicator shall be responsible to post these sheets during the application of the materials.

## 1.08 WARRANTY

- A. The approved applicator and repair manufacturer shall provide a three (3) year warranty for the work specified against becoming unserviceable from either defective or non-conforming materials or workmanship.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. **APPROVED MANUFACTURERS:** Specifications are based on the first named manufacturer. Other approved manufacturers must meet or exceed this standard and must be approved by the owners representative.

1. Fosroc Incorporated, 150 Carley Court, Georgetown, KY 40324, 1-800-645-3954 or 1-502-863-6800

### 2.02 PRODUCTS

- A. **INFILTRATION CONTROL MIX (PRECO PLUG, AS MANUFACTURED BY FOSROC INCORPORATED, 150 CARLEY COURT, GEORGETOWN, KY 40324)**

A premixed portland cement based hydraulic cement consisting of portland cement, graded silica aggregates, special plasticizing and accelerating agents. It shall not contain chlorides, gypsum, plasters, iron particles or gas forming agents, or promote the corrosion of steel it may come in contact with. It shall be formulated at the factory and supplied in factory sealed and labeled pre-measured containers, which shall contain the complete quantity of materials required for this work. Preco Plug shall be used to stop minor water infiltration and shall conform to the following specifications:



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Property	ASTM Test	Result
Set Time	ASTM C-191-92	45-60 Sec.
Compressive Strength	ASTM C-109-91	
10 Minutes		500 psi (3.5 MPa)
1 Hour		1,200 psi (8.3 MPa)
1 Day		2,400 psi (16.6 MPa)
28 Days		6,000 psi (41.4 MPa)

**B. PATCHING MIX** (PRECO PATCH AS MANUFACTURED BY FOSROC INCORPORATED, 150 CARLEY COURT, GEORGETOWN, KY 40324)

A premixed portland cement based hydraulic cement consisting of portland cement, graded silica aggregates, special plasticizing and accelerating agents. It shall not contain chlorides, gypsum, plasters, iron particles or gas forming agents, or promote the corrosion of steel it may come in contact with. It shall be formulated at the factory and supplied in factory sealed and labeled pre-measured containers, which shall contain the complete quantity of materials required for this work. Preco Patch shall be used to fill minor voids and cracks, to bring substrates up to profile, to provide watertight seals at manhole, invert, lateral line and house connections and shall conform to the following specifications:

Property	ASTM Test	Result
Set Time	ASTM C-191-92	3- 5 Min.
Compressive Strength	ASTM C-109-91	1 Hour
700 (4.8 MPa)		1 Day          2,000 (13.8 MPa)
28 Days		5,500 (37.9 MPa)

**C. CEMENTITIOUS LINER MIX - WET PROCESS** (RENDEROC SP15 AS MANUFACTURED BY FOSROC INCORPORATED, 150 CARLEY COURT, GEORGETOWN, KY 40324)

Renderoc SP15, a cementitious, micro silica and fiber enhanced wet shotcrete material designed to be mixed with water, pumped and then shot against a properly prepared substrate. Renderoc SP15 shall conform to the following specifications:

Property	ASTM Test	Result
<b>Compressive Strength</b>	<b>ASTM C109-92</b>	
1 Day		4,000 psi (27.5 MPa)
7 Days		7,000 psi (48.2 MPa)
8 Days		9,000 psi (62.0 Mpa)



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<b>Flexural Strength</b>	<b>ASTM C78-84</b>	
7 Days		750 psi (5.2 MPa)
28 Days		1,000 psi (6.9 MPa)
<b>Bond Strength</b>	<b>ASTM C882-91 Modified</b>	
7 Days		1,750 psi (12.0 MPa)
28 Days		2,250 psi (15.5 MPa)
<b>Splitting Tensile</b>	<b>ASTM C496-90</b>	
7 Days		600 psi (4.1 MPa)
28 Days		700 psi (4.8 MPa)
<b>Sulfate Resistance</b>	<b>ASTM C 267</b>	
84 Day immersion in Sulfuric Acid solutions	Weight loss	pH1.0 <9% pH2.0 <.30% pH3.0 <.18%
	Compressive Strength %change ASTM C109	pH 1.0 <7% loss
	pH 2.0 <1.0% loss	
	pH 3.0 <0% loss	

**D. LINER PROTECTIVE COATING** (FOSROC EPOXY LINER TG AND FOSROC EPOXYLINER HBS 100, AS MANUFACTURED BY FOSROC INCORPORATED, 1500 CARLEY COURT, GEORGETOWN, KY 40324)

Fosroc Epoxy Liner is a three component system consisting of epoxy resins and a special blend of chemical resistant fillers for total manhole wall rehabilitation. Fosroc Epoxy Liner HBS 100 is a two component, thixotropic epoxy coating system designed for vertical high build applications. Both products can be used where hydrogen sulfide conditions can be expected, (pH below 2.0).

Fosroc Epoxy Liner TG		
Property	ASTM Test	Result
<b>Tensile Strength (filled)</b>	<b>ASTM 307</b>	
7 Days RT		1600 psi minimum
<b>Compressive Strength (filled)</b>	<b>ASTM C579</b>	
7 Days RT		9000 psi minimum



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## Flexural Strength (filled)

**BS63197**

7 Days RT

4000 psi minimum

## Fosroc Epoxy Liner HBS 100 (sprayed applied)

Mixing Ratio	1:1 by volume
Tack Free Time (72F)(2 1 C)	3-5hrs.
Initial Cure	1 day
Final Cure	7 Days
Mixed Viscosity, cps	16,000-20,000
Adhesion to 6 hr old concrete or microsilica mortar ASTM D4541	> 400 psi (concrete failure)

## E. SEALING STRIP (INFIL-STRIP AS MANUFACTURED BY FOSROC INCORPORATED, 150 CARLEY COURT, GEORGETOWN, KY 40324)

Fosroc Infil-Strip is a tape for sealing joints inside manholes particularly between the metal frame casting and the cone section. Infil-Strip is flexible, waterproof self-healing when punctured, and when properly applied with Fosroc Epoxy Liner forms a permanent waterproof seal between virtually any manhole surface and the casting.

Property	ASTM Test	Result
Tensile Strength	ASTM D-882-91	200 psi min
Elongation	ASTM-D-882-91	300% min.
Softening Point	ASTM-D-36-86	220 F (104 C)

## G. WATER

Water shall be clean and potable. Questionable water shall be tested by a testing laboratory in accordance with ASTM C-94. Potable water need not be tested.

## PART 3- EXECUTION

### 3.01 EXAMINATION

- A. Exam the existing manhole for leaks and deteriorated concrete and/or bricks/mortar.

### 3.02 PREPARATION

- A. Place covers over invert to protect extraneous material from entering the sewer lines.



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- B.** Remove any existing metal steps, and patch holes with Preco Patch or Plug.
- C.** All foreign material shall be removed from the manhole wall and bench using a high pressure water spray (minimum 3,000 psi 3 gal/mm.). Loose and protruding brick, mortar, and concrete shall be removed using a mason's hammer and chisel and/or scraper.
- D.** Active leaks shall be stopped using Preco Plug, according to manufacturer's recommendations. Some leaks may require weep holes to localize the infiltration during the application after which the weep holes shall be plugged with Preco Plug prior to the final liner application.

## 3.03 APPLICATION

### A. WEATHER

1. No application shall be made to frozen surfaces or if freezing is expected to occur inside the manhole within 24 hours after application, or until 500 psi(3.5 MPa) is reached.

### 2. LINER MIX (WET PROCESS)

If ambient temperatures are in excess of 95F (36C), precautions shall be taken to keep the mix temperature at time of application below 90F (32C). Mix water temperature shall not exceed 850F (290C). Chill with ice if necessary.

### B. EQUIPMENT & EXECUTION

#### 1. INFILTRATION CONTROL AND PATCH MIX

Small amounts Preco Plug and Preco Patch should be mixed as required per the manufacturer's recommendations.

#### 2. LINER MIX - WET PROCESS (RENDEROC SP15)

Application equipment shall be a low velocity mortar spray pump capable of applying Renderoc SP15 at the recommended water/cement ratio as outlined on the product data sheet to achieve the physical properties.

#### 3. LINER PROTECTIVE COATING (TROWEL APPLIED)

Thoroughly mix the three components in a clean pail using a steel paddle on a low speed (400-600 rpm) drill for approximately 5 minutes. Apply the mixed mortar using standard steel hand trowels.

#### 4. LINER PROTECTIVE COATING (SPRAY APPLIED)



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Thoroughly mix the two components in a clean pail using a steel paddle on a low speed (400-600 rpm) drill for approximately 5 minutes. Apply the mixed material using a 45:1 or 56:1 airless sprayer with reverse-a-clean tips with an orifice size of .018" - .025".

## C. INVERT REPAIR

1. After all preparation has been completed, remove all loose material and wash wall again.
2. Any bench, invert, or line repairs shall be made at this time using Preco Plug and/or Preco Patch.
3. Invert repair shall be performed on all inverts with visible damage or infiltration. After blocking flow through the manhole, and thoroughly cleaning invert Preco Patch shall be applied to the invert in an expeditious manner. The mix shall be troweled uniformly onto the damaged invert extending out onto the base of the manhole sufficiently to tie into the Renderoc SP15. The finished invert surfaces shall be smooth and free of ridges. The flow may be re-established in the manhole within 60 minutes after placement of the mix.

## D. MIXING, LINER MIX (WET PROCESS)

1. For each bag of Renderoc SP-15, use 3 qts. of water for each 50# bag. Mix using suitable mixing equipment for 3 to 4 minutes after all the materials have been placed in the mixing hopper.
2. Place the mix into the holding hopper and prepare another batch with timing such that the nozzle-man can spray in a continuous manner without interruption until each application is completed.

The surface prior to spraying shall be clean and must be free of all foreign material and shall be damp (S SD) without noticeable free water droplets or running water, but totally saturated, just prior to application. The Renderoc SP15 shall be spray applied from the bottom of the wall to the top, to minimum uniform thickness of at least 1/2" up to 4" to insure that all cracks, crevices, and voids are filled and a relatively smooth surface remains after light troweling. The light troweling is performed to compact the material into voids and to set the bond.

## 2. SECOND APPLICATION

If required, a second application is applied after the 1st application has begun to take an initial set. Again, application shall be from the bottom up. The surface is then trowelled to a smooth finish being careful not to over trowel so as to bring additional water to the surface.

## F. BENCH APPLICATION

- 1 The wooden covers shall be removed at this time and the bench sprayed such that a gradual slope is produced from the walls to the invert with the thickness at the edge of the invert being no less than 1/2



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inch. The wall/bench intersection shall be rounded to a uniform radius the full circumference of the intersection.

## G. CURING OF CEMENTIOUS MATERIALS

1. Curing shall be done in accordance with good concrete curing practice as outlined in ACI 308 and in accordance with Manufacturer's recommendations.

## H. APPLICATION OF LINER PROTECTIVE COATING FOSROC EPOXY LINER (TROWEL APPLIED)

1. Allow the liner mix above to cure a minimum of 24 hours prior to applying Fosroc Epoxy Liner. Mix according to manufacturer's instructions. Apply 1/8" thickness with spatula or trowel. To avoid sagging on vertical and overhead surfaces, do not apply mortar greater than 3/4" per layer. Build up to desired level and strike off. Light spray applications of denatured alcohol to the surface and trowel, will aid in finishing.

## I. FOSROC EPOXY LINER HBS 100 (SPRAY APPLIED)

1. Allow the liner mix above to cure a minimum of 6 hours prior to applying Fosroc Epoxy Liner HBS. Mix according to manufacturer's instructions and apply using a 45: 1 56:1 airless sprayer with reverse-a-clean tips. Fosroc Epoxy Liner I-HBS 100 can be applied at 60 to 100 mils in a single application.

## J. APPLICATION OF RESIN TREATED JOINT SEALING TAPE FOSROC INFIL-STRIP

1. The length of Infil-Strip should be based on the circumference of the cone section, not the metal casting Allow at least 6 inches extra length for overlapping of the ends.

2. It is recommended that Fosroc Epoxy Liner be utilized as an adhesive for Infil-Strip. Apply mixed Fosroc Epoxy Liner to the circumference of the metal casting and cone section substrate so that it will come in contact with only the top and bottom 2" above and below the joint or on to the Infil-Strip tape.

3. Remove the paper backing from the Infil-Strip tape and apply it over the casting/cone section joint making sure the black mastic comes in contact with both the casting and the cone section on the pre-applied Fosroc Epoxy Liner.

4. Allow the end to overlap 6" and press firmly one over the other to seal.

## 3.04 FIELD QUALITY CONTROL

A. **TESTING:** At the direction of the owner or his assignee, the rehabilitated manholes shall be tested as follows:



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1. Visually verify the absence of leaks.
2. Perform vacuum test.

## B. PROCEDURE FOR TESTING

1. The lines entering the manhole shall be temporarily plugged with the plugs braced to prevent them from being drawn into the manhole. The plugs shall be installed in the lines beyond drop-connections gas sealing connections, etc. The test head shall be placed inside the frame at the top of the manhole and inflated in accordance with the manufacturer's recommendations. A vacuum of 10 inches of mercury shall be drawn, and the vacuum pump will be turned off. With the valve closed, the level of vacuum shall be read after the required Test Time. If the drop in level is less than 1-inch of mercury (Final vacuum greater than 9 inches of mercury), the manhole will have passed the vacuum test. The required Test Time is determined from the Table below.

## 2. MINIMUM TIME REQUIRED FOR A VACUUM DROP OF 1" Hg (10" hg -9 Hg)

Height of M.H.	48" M.H.	60" M.H.	72" M.H.
0-20 feet	0:40	0:50	1:00
22 feet	0:44	0:55	1:06
24 feet	0:48	1:00	1:12
26 feet	0:52	1:05	1:18

## 3.05 MEASUREMENT AND PAYMENT

1. Payment shall be based on a vertical foot basis. Depth of the manhole shall be measured from the bottom of the invert to the top of the ring seat for the manhole cover.